

greater differences of magnitude, are well shown in some of the results, although in other cases magnitude appears to have made no difference. Thus Admiral Smyth's results show a probable error in angle of $\pm 0''.031$ below $3''$ and $\pm 0''.049$ above $3''$, but it is not certain whether the magnitudes have any influence; there is no evidence of systematic error in the distances, but an average constant error of $\pm 0''.073$ is indicated. Prof. Doberck states that these observations are of very great value. In the case of H. Struve the magnitude coefficient is probably considerable.

FORTY-ONE NEW VARIABLE STARS.—Circulars No. 134 and No. 135 of the Harvard College Observatory announce the discovery of forty-one variable stars. Of the sixteen announced in the former, two show remarkably large variations. One of these, D.M.— $30^{\circ}.2883$, situated in Columba, decreases from magnitude 10.4 to below magnitude 15.0, whilst the other, D.M.— $46^{\circ}.14688$, situated in Phoenix, ranges from 8.5 to less than the twelfth magnitude. The variations of a number of stars announced in Circular No. 129 have been confirmed visually, and of these TT Aquilæ is especially interesting on account of its brightness and probable colour changes. The second circular gives particulars of twenty-five newly discovered variables found in regions Nos. 24, 36, and 42 of the Harvard map. In this research the number of variables found to be of the Algol type has been a remarkable feature, and of the twenty-five now published, eight are probably of this, or of the β Lyrae, class. The large number of variables found in map 42 appears to be significant, and should be taken into account in any discussion of the region, which includes a large portion of the constellation Scorpio and the nebulous region in Ophiuchus.

AMERICAN ETHNOLOGY.

THE American Bureau of Ethnology, with its usual energy, has lost no time in extending its operations over the new colonial possessions, the Philippines, and some West Indian islands. The most important contribution to the twenty-fifth volume of its reports, for 1906-7, is an account of a preliminary survey of Porto Rico and the neighbouring islands, conducted by Dr. J. W. Fewkes.

Porto Rico, the smallest of the Greater Antilles, is naturally linked with Venezuela by the chain of the Lesser Antilles, which stretch southwards to the mouth of the Orinoco. It lies within a region of volcanic disturbance, and it is possible that when it was first occupied by man it may have formed part of an isthmus connected with the South American coast. A temperate climate and a productive soil naturally invited colonisation. The fauna and flora are of the South American type, and many considerations support the conclusion that Porto Rico and the adjoining islands were peopled from the valley of the Orinoco. Thus the houses of the people of both these regions are similar in type, and we find no traces of stone buildings which would naturally have been erected by emigrants from the Maya or other Yucatan tribes. The use of cassava, a South American product, and the care which the primitive inhabitants of Porto Rico, like those of the Orinoco, devoted to the preservation of the skeletons of their dead, are facts pointing in the same direction.

Except in the interior of the island, few traces of the aborigines survive. The inhabitants were massacred by the Spaniards, who re-peopled the island with slaves from the Bahamas and negroes from Africa. From the intercourse of these people with their rulers a half-caste population sprang up. Thus the island at present is occupied by a mixed race, and the absence of a collection of the skulls of the aborigines renders it difficult to decide what their race character may have been. The accounts of their physique and character given by the early Spanish writers do not, however, conflict with the theory of their South American origin.

The relics of this forgotten race are to be found in the dancing plazas, shell-mounds, and caves scattered over the island. The character of their stone carvings and pottery indicates that they had reached a high grade of culture. The plazas were stone enclosures in which ceremonial

dances were performed with the object of securing abundant rain and plenteous harvests, success in war, the cure of the sick, for commemoration rites of the dead, initiation and other ceremonies. They often contain

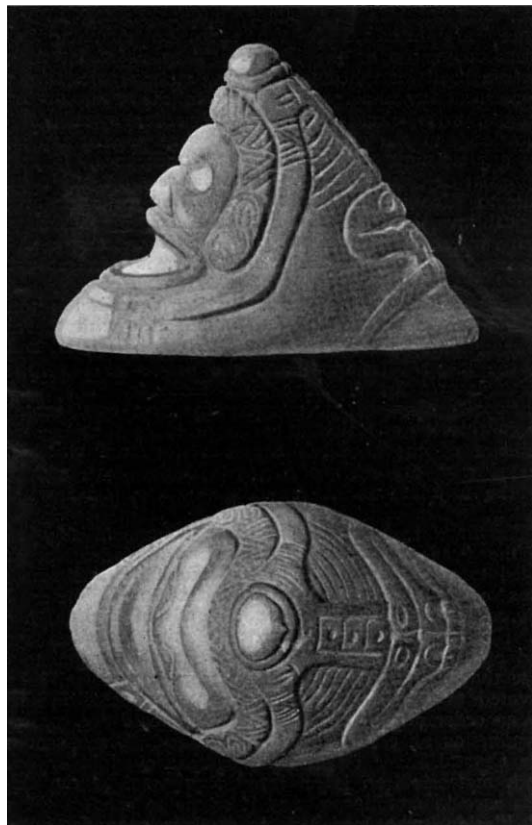


FIG. 1.—Lateral and top views of a three-pointed stone of the second type (Latimer collection); length 3 inches.

water-worn stones, which Dr. Fewkes supposes to have been emblematic of flowing water, and to have been used in some form of mimetic magic to control the rain. Their religion was of the animistic and shamanistic type, and its ritual largely consisted in the worship of Zemi, a term which included their gods, symbols of deities, idols, bones, skulls of the dead—in short, anything supposed to possess magical power.

The most remarkable idols were those of the "three-pointed" anthropomorphic type (Fig. 1). The interpretation of these objects is obscure, and many theories of their origin have been suggested. Dr. Fewkes regards them as clan idols or tutelary totems, the difference in their form denoting different conceptions of the Zemi in the various clans. Equally curious are the zoomorphic or anthropomorphic pestles (Fig. 2), which were employed with mortars in the preparation of food, and the stone collars, which, according to one theory, were used in association with the "three-pointed" images, and with them formed a snake idol. This explanation Dr. Fewkes rejects; but, except that they must have been used for some religious or ceremonial purpose, their meaning is still uncertain.



FIG. 2.—Bird-shaped pestle from Sauto Domingo.

The rude pictographs or petroglyphs found in the island are equally remarkable. Some of the best specimens are engraved on boulders in rivers or in their vicinity, thus possibly indicating their use in some mimetic rain ceremony. Others, drawn with less care, differing from the river sculptures in size, shape, and apparently in significance, are inscribed in the caves so common in the calcareous rocks of the island. They represent in some cases a head furnished with horns, human faces, and rude representations analogous in type to the "three-pointed" images, with circles, spirals, and other symbols. Our knowledge of the aboriginal cults is at present too scanty for any attempt to explain their significance. That they represent objects of religious worship seems fairly certain.

Porto Rico is thus a most promising field for archaeological investigation. The report of Dr. Fewkes suggests many interesting problems. It is well written, and, like other publications in the same series, is admirably illustrated.

Another article by the same writer describes a tour of exploration in eastern Mexico, undertaken with the object of ascertaining the relationship between the mound builders of the lower Mississippi and the people of the Mexican coast known as Totonac and Huastec. The Totonac metropolis, Cempoalan, was for the first time examined. From this investigation it seems probable that the mound builders of the southern States were more closely connected with the races of eastern Mexico than with those of the arid region of the south-west or even with the plateau tribes of eastern Mexico.

The third part of the thirteenth volume of the *Journal of the Academy of Natural Sciences*, Philadelphia, is devoted to a fresh exploration of Moundville, Alabama, and sites on the Crystal, Chattahoochee, and Lower Flint Rivers, and the Ten Thousand Islands of Florida, by Mr. C. B. Moore. The appearance of the Swastika symbol and other objects discovered at Moundville seems to indicate that this was an important religious centre, specially devoted to the worship of the sun, conducted in temples by an order of priests, who kept the sacred fire continually burning as an emblem of the luminary. The discovery at the Crystal River of an ear-ornament overlaid or covered with meteoric iron is an interesting proof of the skill of this race in metallurgy, and it seems to connect the races of Florida, who buried their dead in mounds, with the people of the Ohio valley region. This report also is provided with excellent illustrations of the remarkable series of finds which were secured by Mr. Moore's expedition.

THE NITROGEN PROBLEM IN AGRICULTURE.¹

FOR many years what is known in agriculture as the nitrogen problem has received considerable attention both from men of science and from practical men. It has two aspects. Few soils contain nitrogen compounds in sufficient quantity for the needs of non-leguminous crops, and the application of nitrogenous manures is one of the commonest, as well as one of the more costly, operations of modern agriculture. On the other hand, leguminous crops not only need no nitrogenous manure for themselves, but actually increase the store of nitrogen compounds in the soil, and dispense with the necessity of adding more for the succeeding crop. The problem would obviously vanish if leguminous crops could be grown every other year, but unfortunately they are liable to "sickness," and can only be grown once in four or even six years. Even as it is, however, any method that increases the nitrogen-fixing power of a leguminous crop is a welcome addition to the resources of a farmer.

In 1886 Hellriegel and Wilfarth showed that nitrogen-fixation is the work of certain micro-organisms associated with the leguminosæ. It has since been shown that they can grow apart from the plant, and can be inoculated into soils, and also that an increased crop may follow such inoculation.

On three occasions cultures of these organisms have

¹ "Seed and Soil Inoculation for Leguminous Crops." By Prof. W. B. Bottomley. (London: *Country Life* Office.)

been widely distributed among farmers. In 1896 Nobbe sent out "nitragin"; in 1903 Moore's cultures were issued in America; and now we have Prof. Bottomley's cultures. Each time very great and widespread interest has been aroused, the matter has been discussed at length in the daily Press, and has even on occasion formed the subject of questions in the House of Commons. The subject appeals to almost everyone. Few scientific problems are more interesting than the wholly unparalleled synthesis of complex organic compounds from free nitrogen and other simple bodies effected by these micro-organisms at the low temperatures of the soil. The practical man sees in inoculation the possibility of increased leguminous crops and of less expenditure on nitrogenous manure for his other crops. The man in the street, who has always been ready to take an interest in nitrogen since Sir William Crookes's British Association address at Bristol in 1898, sees the threatened nitrogen famine averted and his food supply rendered secure for a long time to come.

Inoculation has proved very successful on virgin soils, or in dealing with new leguminous crops, but there is little or no evidence that it is effective when the soil is already in cultivation and the crop no longer new. Nobbe's cultures failed, and Moore's cultures were not particularly successful when applied in ordinary farm practice. Certain other less boomed cultures, e.g. Hiltner's, have done better, and have sometimes given 20 per cent. or 30 per cent. increases in crop. Prof. Bottomley tested his culture by distributing more than a thousand specimens; 80 per cent. of the reports received (unfortunately we are not told the actual number) showed an increase in crop. The pamphlet before us consists largely of extracts from these reports.

Experiments of this nature are very difficult to carry out. Great care is necessary in selecting the ground, proper control plots are needed, and the experiment must be continued for several years without essential modification. Under favourable conditions, the error of a field experiment lasting many years may be as low as 5 per cent., but for shorter periods it is much higher. We cannot find any evidence that these facts have been taken into account; on the contrary, most of the trials have obviously been made by novices. Only in a few cases have any weights been taken, and the results have usually been guessed. Here is an "experiment" with peas:—

"I planted the inoculated peas on land that had not been manured for many years, and had a crop of peas quite equal to those grown by a friend on manured soil" (p. 24).

Another:—"Gradus' without inoculation, a fair crop, but they were soon over."

"Sutton's A 1' inoculated, heavy crop, with abundance of well-filled pods" (p. 21).

Again:—"First sown peas, inoculated, a fine crop. . . . Second sowing, uninoculated, results very poor. . . . The ground on which first crop was sown had had no peas on it for several years, whereas the ground on which second crop was sown had had peas grown on it in the previous year" (p. 17).

It is scarcely necessary to say that statements of this kind are of no scientific value.

Fifty-two reports are quoted; fifteen must certainly be rejected, eighteen give no figures, thirteen give estimated figures, and six give weights. Confining our attention to the nineteen cases where figures are given, we find that in four the increased yield is 20 per cent. or less; this cannot be much greater than the magnitude of the experimental error. In nine cases the estimated increase is 30 per cent. to 50 per cent., and in five cases more than 50 per cent. A detailed discussion is obviously impossible; we can only point out that a few experiments properly made on sound lines would have been very much better than all these testimonials. So far as they prove anything at all, however, they go to show that the author has, like Hiltner in Germany, Moore in the United States, and Golding here, obtained cultures which may in suitable cases increase the yield of leguminous crops, and the increase seems to be estimated in the majority of cases at about 30 per cent. to 50 per cent.

Now if it this turns out to be correct it will be a very useful result, but in ordinary farming it can only be